REPORT

—OF—

SPECIAL

Committee on Sewerage,

FOR THE

TOWN OF BROCKVILLE, ONT.

WITH

REPORTS AND PROPOSED PLAN

BY

WILLIS CHIPMAN, C. E.

AND

GEO. E. WARING, ESQ.,

SANITARY ENGINEER.

INCORPORATED 1832

BROCKVILLE:
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REPORT OF SPECIAL COMMITTEE

To the Honorable Municipal Council of the Corporation of the Town of Brockville,

The Special Committee on Sewerage respectfully submit the following

REPORT:

Of late years the introduction of a water system, the bad state of your streets, and the alarming prevalence of that class of diseases whose spread is generally due to want of proper drainage, have forced the question of sewerage strongly upon our citizens.

Brockville has no system of sewerage. Drains have been constructed here and there as required, with very little regard for sanitary principles, bringing about a state of things that is fully described in the report which follows this.

Naturally our town is in a situation most favorable to the health of its inhabitants. With its sloping streets, its dry soil and the river—the purest in the world—Brockville should show the lowest of death rates. But our natural advantages are counteracted by that most serious of grievances—the want of drainage. Fortunately this is now in a fair way to be remedied.

The council last year made the first move towards getting a system of sewerage by engaging Mr. Willis Chipman, C.E., to make a plan showing the elevation of all parts of the town, in order that the position and size of the necessary sewers might be accurately calculated. Mr. Chipman also, at the council's request, made a trip through the North-eastern states, visiting the principal cities with a view to gain information respecting the most approved systems of drainage in use there. On his return a report was drawn up by him, advising the use of what is known as the "Restricted System," for reasons given in the report.

The plan and report were laid before a meeting of ratepayers and discussed there without any satisfactory result, the opinions of those present being very diverse and conflicting.

A new council (the present one) was elected, and soon after we had the honor of being appointed a committee from your honorable body for the purpose of forwarding the sewerage question, and of consulting with Mr. Chipman in regard to it.

It was decided to begin by getting the very best advice available, so that a system might be adopted, on the success of which everyone could confidently rely. This we believe was done when we were so fortunate as to secure the services of Col. G. E. Waring, one of the most famous of sanitary engineers.

Col. Waring, after referring to the sources of information provided for him, and after making a personal examination of the town, submitted a report in which he advocated the "Separate System" as the cheapest and most applicable to our case.

The engineers estimated the cost of constructing sewers on this system at $66,000.

Several schemes for raising the required funds were advanced by members of this committee and others. We held several meetings to discuss these, and also procured legal advice both here and in Toronto. Finally we decided that what is known as the "Frontage System," or "Local Assessment System" would be the most equitable, a certain portion of the cost, however, being borne by the corporation, because, though some parts of the town would receive much greater benefit than others, from the construction of the sewers, and the street improvements that must necessarily follow this construction, the whole community would certainly be greatly benefited.

We then advised the adoption of two by-laws, the one called "A by-law for constructing drains in the town of Brockville, and for raising the sum of $30,000 towards the construction thereof,"* the other entitled "A by-law to provide that future expenditure in the town of Brockville for drainage, sidewalks, roads, pavements and such public works shall be by special assessment on the property benefitted, and not exempt by law from assessment."

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*This by-law also provides for the appointment of three commissioners who shall superintend the construction of the drainage works under the orders of the council.

These by-laws have been drawn up at your request and will be voted on by the electors on the 8th of November next.

Before that time it is advisable that the electors shall be fully posted on this question, therefore with this report of your special committee are published the reports of Mr. Chipman and Col. Waring, so that everyone interested may have an opportunity of fully understanding the matter before further steps are taken.

We believe that the sewerage question is the first and most important one for your consideration; and that though it involves considerable outlay at present, the future benefits to be derived from it ought to outweigh all idea of expense.

We must have a system of sewerage, the only thing that remains for you is to adopt the system which, while being thoroughly reliable, will at the same time be the least expensive.

Respectfully submitted by

G. H. Weatherhead,
V. R. Marshall,
D. W. Downey,
A. F. Stagg,
Special Com. on Sewerage.

Brockville, Oct. 4th, 1886.

COL. G. E. WARING'S REPORT.

To the Honorable the Mayor and Council of Brockville:

Gentlemen,—Having visited your city and examined the various conditions which should influence the manner of its sewerage, I beg to submit my opinion as follows.

As I understand your circumstances, you find it necessary to introduce some general system of sewerage covering the principal part of your city, for the disposal of the wastes of houses, etc.; you have occasion for some regulation of the discharge of storm water; it is especially important that the discharge of house sewage be so regulated as to avoid a suspicion of fouling the water supply; the currents along your immediate shore are subject to eddies which are not at all times the same; and it is important that in the solution of your problem you adopt a system that shall not be too costly.

The latter consideration being an important and controlling one, it seems necessary to consider the magnitude and consequent cost of the works to be constructed. This involves a careful examination of the degree to which it is necessary that your whole outflow, foul sewage as well as storm water, needs to be provided for by underground channels.

If the question of cost could be set aside, I see no special objection to the adoption of a system of large sewers capable of carrying foul sewage and all of the water of ordinary rains, leaving only the rainfall of excessive storms to find an outlet over the surface. The cost of such a combined system would, however, in my judgment, be more than twice as great, including the cost of outlet, as would a system adapted to the removal of foul water only.

The cost would be much reduced by adopting a restricted system, taking only the foul sewage and the water from roofs. This, however, would require very large pipes, and especially a large and costly outlet; while if roof water were depended upon exclusively for flushing the sewers, there would be no flushing during the long dry periods of summer, when, owing to the higher temperature, flushing would be especially important.

It seems to me, therefore, that your wisest course would be to adopt a strictly separate system, receiving the foul wastes from houses and factories only, and flushed from the water supply by automatic flushing tanks, one of these being placed at the head of each branch of the sewers. I have the less hesitation in recommending this more economical method in your case because of the considerable inclination of the surface of nearly every part ot your city. Proper paving and the proper regulation of street gutters which would naturally accompany paving, would, in nearly all cases, suffice for the speedy and unobjectionable removal of storm water. Occasional underground channels might be needed to remove an accumulation of surface flow from certain low places, but the need for them would be very exceptional and their cost would be comparatively trifling.

For this system, I think that the lines of sewers indicated in the plan submitted by Willis Chipman, Esq., are very judicious and satisfactory. A few slight changes in the lines here indicated may be found desirable, in view of the position of underlying rock, but as a whole, the network indicated is a very good one.

One of the controlling elements of the work should be the main outlet. I believe it would be extremely unwise to follow the courses of the streets running directly toward the river and to deliver the sewage of each street at its foot. The generally upward, but sometimes changing currents along the shore, where the outlet is toward the main river, would not favor a proper immediate disposal of waste matters, while a large and very important portion of the river front is shut in behind piers, making practically stagnant land-locked bays, which are peculiarly unsuited for the reception of sewage matters.

By examining the levels and grades over that portion of the city which it is proposed now to sewer, it will be seen that with the single exception of a narrow strip along the river, east of Market Square and below King Street, everything as far north as Pearl and as far west as Perth street can be delivered at one outlet west of the end of the C. P. R. pier. All of the system from King street north may be delivered through Mill street. It would, however, be quite expensive to confine the channel of the creek in such a way as to deliver its flow and that of the sewers out into deep water.

By following Mill street to Jones stıeet, Jones street to Kincaid street and a line across private property from the end of Jones street to Home street at a point north of Gourlay street, the whole flow of this main part of the system can be delivered at the foot of Home street.

To deliver immediately at the foot of this street, however, would be very objectionable, and I recommend the continuation of the main sewer on a prolongation of the line of Home street to a point in St. Lawrence river 1,000 feet distant. The cost of constructing this outlet 1,000 feet long will in any case be considerable, but it would be very much greater with the Restricted system and still greater with the Combined system, because of the enormous capacity required for the outlet pipe. If the district under consideration is completely sewered on the separate system, its sewage, even after its population shall have numbered 10,000, can be freely delivered through a pipe 12 inches in diameter. The cost of a pipe of this size running 1,000 feet into the river will not be unreasonable. It might answer a very good purpose to make a point of discharge only 800 feet from the shore ; but as this is the main feature of the whole system and the key to final success, it would hardly be wise to hazard the absolute success that the more distant point would imply for the saving of a relatively trifling additional cost

This outlet pipe should be of cast iron, 12 inches in diameter, 12-foot lengths, jointed with india rubber rings in place of lead packing, so as to allow a little flexibility, enabling the pipe to accommodate itself to the irregularities of the bed of the river. It may be laid in a cradle, lying on temporary, lubricated ways, running up Home street as far as King street, a distance of about 700 feet ; this portion when laid being moved forward to admit of the laying of the remaining 300 feet without interfering with traffic on King street. When the whole length is ready, a hawser can be passed through it and made fast at the upper end, and the whole line can be drawn into the river by a steam tug. The details of construction of cradle and ways would be simple.

This pipe being laid it would serve as an outlet, as before stated for the whole system under consideration.

The next important point relates to the line to be selected for the main sewer within the town. Surface indications point very clearly to the adoption of King street. It has, however, been suggested that the amount of rock, of the hardest character, to be excavated in this street would constitute a serious objection to the selection of that line. If this objection is a controlling one, then the main might leave King street at Market square, pass down the west side of Market square and through West Water street, Broad street and Jane street to Home street and there connect with the main outlet. Jane street is three feet lower near Broad street than it is at Home street. The probability is that it would be necessary to raise the grade of the east end of Jane street somewhat on this account, to the greater or less inconvenience of those living along it. The adoption of this line would, however, be practical. Were it adopted, a sewer could be built in King street from Home street west to Mill street, to connect with the main coming down John street. The sewer on George street from Court House Square to John street would remain as shown. This would leave the lower part of Buell street, Court House avenue and Main street from Market Square to Home street to be provided for separately. Sewers for this portion could be connected with sewers on Broad street, St. Andrew street, and Apple street, but even then it would be necessary, in order to afford complete drainage to all the houses, to run local lines on King street.

It is worth while, therefore, to consider very carefully the conditions required for the successful operation of a sewer on King street, in order to see to what degree the necessity for rock excavation should constitute an objection.

The difficult point lies between Home street and Garden street. From Garden street east the rise is abundant, being 1.5 foot to Bethune street, and 7.0 to Orchard street. The lateral streets coming from the north toward King street have ample fall and the only reason for making a very deep sewer in this part of King street is to provide house drainage for the cellars of houses on that street. As I understand the case, the houses on the north side of King street have no deep cellars, owing to the rock, and need no cellar drainage. The houses on the south side, so far as subsoil water is concerned,—the only need for cellar drainage—can find sufficient outlet to the south towards the river. The houses on both sides can have their water closet and sink drainage delivered at a little depth. This will be an advantage to the property owners as obviating the necessity for deep private drains through the rock. If, as I am informed, the rock is nearer to the surface on one side of the street than on the other, the probability is that by sounding in cross-sections, a line can be found for the sewer which would require much less rock cutting than if it were run straight. The increase of length caused by such deviation would not be important as affecting the fall.

I suggest therefore that from the head of Home street to Garden street, the sewer have an inclination of 1 to 600, its diameter being 12 inches; that it be made 6 feet deep at Garden street, or be laid at a grade of 33.5; this will make it about 8 feet deep at Buell street and will make the average cutting for the whole distance about 7 feet, which would not be very serious.

As a sewer laid on such a grade and carrying the small amount of sewage that it is likely to receive for some years to come, would be subject to deposits if depending only on its natural flow, I suggest that in Bethune street, somewhere south of Pine street, there be constructed a flush tank having 1,000 cubic feet capacity, which shall receive the sewage from Bethune street, from James street east and west, and from the branch sewers in Park street and Orchard street leading into James street. This flush tank may have a discharging depth of 6 feet and may constitute a part of the regular system of discharge through Bethune street. It will retain all sewage coming to it until it becomes full and will then discharge its whole volume with such velocity as to constitute a thoroughly effective flush for the low grade sewer on King street. The sewer in Bethune street between the flush tank and King street had also better be made 12 inches in diameter. It should enter King street on a curve of not less than 20 feet radius, in order to maintain a good velocity. This flush tank with those placed at the heads of branch sewers, will maintain the whole system in good condition.

There is a storm water sewer in John street, from the north side of James street to the creek. It is low enough at James street to furnish an outlet for the sewer as laid down on Pearl street. It will have ample capacity for its storm water work if the pipe sewer be laid in its bottom, having its joints cemented and being bedded in broken stone throughout the whole length of the John street sewer from James street down. This sewer can be used as an outlet for the drainage of Perth street from Pearl street to King street and for a short distance west of Perth street on Church street.

The Brock street system cannot be well connected with this John street sewer. In fact, all of the territory north of Pearl street and the territory west of Perth street so far as it slopes toward the valley of the creek will have to be accommodated, when its systematic sewerage becomes necessary, by an independent outlet laid in the valley of the creek. I have been asked whether the creek in its present condition will not take care of the sewage of this district for ten or fifteen years to come. The answer to that question depends solely on the rapidity with which population in that district increases. It is sufficient for present purposes to say that it cannot be connected at any point with the system now provided for between Pearl street on the north and Perth street on the west.

The district below King street and east of Market square should be provided with a small separate system of its own, delivering at the foot of Ferry street, where there is a nearly constant eddy setting up toward the C.P.R. pier and following that pier to the main current of the river. The alternative for this arrangement would be to pass under the railroad tunnel with a siphon and connect with the west Market street sewer.

The line running through west Market street, Broad street and Jane street, whether a main sewer for the larger district, or intended for local purposes only, will have to be so arranged as to overcome the depression in Jane street between Broad street and St. Andrew street. It may be, in the case of a small sewer for local purposes only, the best course to pack the sewer where too shallow in sawdust or other non-conducting material. It is to be remembered that sewage is very much warmer than the air in winter and that the freezing of sewers is rarely to be apprehended; indeed, it is stated that the water flowing in the open gutter through the tunnel is never frozen; this water is much colder than house sewage. Under no circumstances can the lower portions of St. Andrew street and Broad street, with the connecting line on Flint street, be drained into the Jane street main. If sewers are built here at all they must necessarily deliver into the tunnel bay.

One very important consideration in Brockville is the provision of ample drainage for cellars. The best way to effect this is to secure sufficient drainage of the ground. Ordinarily, it will not be necessary to carry drains directly to the cellars. Any method by which the general level of the subsoil moisture can be reduced will suffice to prevent their invasion, and experience elsewhere has shown that by laying ordinary drain tiles in the sewer trenches at the sides of the sewer pipes and enough lower to pass under house drains, will sufficiently reduce the general subsoil water level. For remote houses having cellars subject to springs, something more may in special cases be necessary. An outlet for their water can be furnished by the use of agricultural drain tiles laid in the same trenches with the house drains, these being carried to a point a little below the level of the cellar bottom.

While these house drains should be laid in the same trenches with the sewer pipes, they should not deliver their flow into them but should be given an outlet to the surface, either into existing deep drains or at the shore. If connected with the sewers they would have the effect of so increasing the flow as to require the construction of a larger outlet pipe into the river.

The question of the cost of flush tanks has been raised. It is a sufficient answer to say that, in the absense of a patent on the flush tanks in Canada, their cost will be considerably less than in the United States, and that in any case the cost of a flush tank at the head of a sewer would be much less than the cost of inlet basins and connecting culverts if reliance were placed on surface water for flushing the sewers.

I think that by the use of Phillipson's inclined inspection pipes at intervals of 300 feet, the use of manholes may be dispensed with on the smaller lines of sewers. Manholes should be used at reasonable intervals, usually at junctions, on sewers 10 inches in diameter and larger. If manholes are constructed on 6-inch and 8-inch sewers they should be arranged only to give access to covered handholes in the sewers passing through them. There should be no opening directly from such small sewers to the surface of the ground by which it would become possible by raising a manhole cover to throw in bulky substances which might cause their obstruction.

The size of the sewers may be easily regulated by your local engineer in accordance with the following rules :

No house drain should be larger than 4 inches in diameter.

No sewer should be less than 6 inches in diameter.

No sewer should at any time run more than half full. In regulating this, assume both sides of all streets to be closely built with houses 25 feet wide and having seven persons to the house, each person using 50 gallons of water per day and one-half of the daily flow being discharged in 8 hours. This will give ample margin for all future population, leaving at least one-half of the sewer available for ventilation.

For ventilation every house drain should connect with the sewer above the centre line; should have no trap anywhere in its course; and should connect with at least one soil pipe 4 inches in diameter, extending above the roof of the house, open to the air at its full size.

The submerged 12-inch iron outlet will of course run full. Its size should therefore be kept smaller than that of the local mains running half full, in order that its whole flow may have sufficient velocity to prevent deposits. A 10-inch pipe would answer a good purpose for many years, but it would be better, with a view to future use, that it should be 12 inches in diameter, as recommended above. The rapid discharge of the flush tank containing 1,000 cubic feet of sewage would furnish a cleansing flow through this sewer. Even without the flow from the John street main, the discharge of the flush tank alone would constitute an effective flush for this pipe.

In any case, whatever system is used, I think the smallest possible amount of sewage should be delivered into the tunnel bay.

I see no reason for changing the arrangement of the sewers if some other than the separate system is used.

Respectfully submitted,

GEO. E. WARING.

Newport, R. I., June 2, 1886.

REPORT OF WILLIS CHIPMAN, C. E.

To the Special Committee on Sewerage of the town of Brockville :

GENTLEMEN,—During the months of August and September of last year I prepared for your committee a contoured plan of the town of Brockville, showing the elevation of all street intersections, above datum,* the directions of the river currents, rock exposures, &c., &c., with a view to ascertaining the cost of a system of sewerage. Parts of this plan were compiled from data in the town clerk's office and part from surveys, levels and personal examinations.

SEWERAGE SYSTEMS OF CITIES AND TOWNS IN THE UNITED STATES.

In September, 1885, I was asked by your committee to visit some of the towns of New York state and the New England states and examine their sewerage systems. At every place visited I found the city engineer and the other officials ready to give any information desired, and advise freely as to the methods to adopt in Brockville.

Nearly all these towns and cities were sewered by what is known as the combined system, and naturally enough the majority of engineers were found to favor this system.

FIRST REPORT.

Upon my return a report was presented to your committee recommending the adoption of the *restricted* system, in which about one third of the rain fall was to be allowed to enter the sewers and serve for flushing them.

This system was more particularly recommended, as the chief reasons advanced for a system of sewerage by the general public were street drainage and cellar drainage.

In this report the main points of the system proposed were a main sewer along King street from the east end of the town to John street, connecting at John street with a main constructed on said street low enough to intercept the sewer on Brock street.

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*The datum adopted was 0.75 feet below the Ogdensburg datum with which it was compared. In August 1885 the assumed datum was 2.66 feet below the water surface of the river St. Lawrence at the foot of Orchard street.

The sewage of nearly all that area of the town lying east of Perth street, south of the Grand Trunk Railway and north of King street, was thus to be brought down to Mill street at King, thence down Mill street to the outlet of Shepherd creek.

The sewage matter with the waters of the creek were then to be enclosed in a dyked channel and conveyed out to such a distance as would ensure the foul water not returning to the neighboring bays.

This plan also proposed that a storm overflow be constructed down Bethune street, which upon further examination I concluded should be located at the foot of Ferry street, the object being to decrease the size of the sewer down King street.

The estimated cost of the system thus proposed was over $85,000, which with the catch basins, man-holes and outfall at foot of Mill street would have been increased to about $105,000. As no thorough examination of the streets had been made to ascertain the exact location where rock would be met with, this amount might still be too small by $10,000 to $15,000.

SYSTEM PROPOSED BY COL. G. E. WARING.

This estimate was considered by many larger than the town could afford, and in May last Col. Geo. E. Waring, of Newport, R. I., was corresponded with and his services secured for an examination of our town, and to advise us as to the location of outfall sewers, and report generally on the system, with a view to cheapen it as much as possible.

Col. Waring, after an inspection of the town and an examination of the plans and such other data as we could furnish him, submitted his report, advising the adoption of the Separate System. As by this system no storm water is allowed to enter the sewers the sizes as proposed in my report will be reduced, no catch-basins or gullies will be required and the main sewer down Mill or Home streets being of a small size can be carried out into the river as a flexible iron pipe, instead of confining the Shepherd creek, and the sewage emptying into it, by dykes, a much more expensive work.

The following report describes the main system as now proposed to be adopted.

Most respectfully yours,

Brockville, Oct. 11, 1886. WILLIS CHIPMAN.

REPORT

ON THE PROPOSED

SYSTEM OF SEWERAGE

FOR THE

TOWN OF BROCKVILLE.

However beautiful and healthful the situation of the town of Brockville, and however pure the breezes of the St. Lawrence, we cannot close our eyes to the fact that we are accumulating in our midst all the elements for the spread of preventable diseases.

PRESENT STATE OF OUR DRAINAGE.

Pure air, pure water and pure soil are three requisites necessary for the longevity of the human race. Pure air can only be obtained where the soil is pure, as emanations from impure polluted soil must contaminate the air with with it is in contact. Of pure water we now have, in the more densely populated part of the town, an abundant supply since the establishment of water works, of which the inhabitants are fast availing themselves.

With the introduction of a system of water works, the amount of water used is much increased, followed as it is by the all but universal use of bath tubs, wash basins and water closets. The central part of the town is now using about 120,000 gallons of water per day from the water works, and it is safe to say as much more from wells. This large amount of water, after being used and polluted, must be got rid of in some way.

A visit to any of the present outfall sewers will convince anyone that only a small portion of this sewage ever reaches the St. Lawrence, and therefore a large amount of it must be absorbed into the soil surrounding the leaky drains or cesspools into which it is discharged, whence a portion is evaporated into the air, while a portion finds its way into the wells to begin its journey again.

From an inspection of a map of the town of Brockville, made by John Booth, about the year 1833, I find the part of the town then thickly populated to have been south of Church street, from Perth street to Market street, the oldest part of this being along Main or King street and between it and the river.

In this part of the town especially the ground must be honeycombed with cesspools, wells and privy vaults alternating with each other, the soil being saturated with sewage and reeking with the accumulated filth of a century.

The worst and at the same time most common nuisance in a sanitary sense that exists in a city or town is the privy vault. But in Brockville besides the ordinary privy vault and private cesspool, we have cesspools beneath our streets, hundreds of feet in length, which, during every drought and after every storm, send their infected and malarial contents into our streets.

REASONS FOR ADOPTING SOME SYSTEM.

Prof. S. W. Johnson, of the Sheffield Scientific School, at Yale College says :

"The use of open vaults or water closets emptying into cesspools, "tends to fill up the soil with fæcal matter. A single vault poisons "a circumscribed space around it. External to this limit the filth is "destroyed by the action of the oxygen of the air, which is the great "purifier. Within the limits named, the animal matters preponder-"ate either constantly or at some period of the year. They may " long remain simply disagreeable, without being dangerous, and "may again, of a sudden, in a way whose details have as yet escaped "investigation, become a seed-bed or nursery of the infection that "breaks out in fevers and dysentery. The danger increases as the "quantity of filth and the number of its receptacles increase. To "cover them up does not necessarily remove the evil. The putrid "matters soak into the soil and move upward and downward in it "with the motion of the soil-water. When we have copious rains "they are carried down, perhaps, to nearly the level of the waters in "our wells. In the heat and drought of August these matters rise "again. In the absence of the rain, the rapid drying of the surface "creates an upward capillary flow of ground-water, The matters “which in rainy times follow the surface-water to the depths, in “drought follow the ground-water to the surface.”

The following extracts are from Waring’s “Sanitary Drainage of Houses and Towns.”

“There are several diseases which are now known to indicate “more or less definately unfavorable sanitary arrangements, and as “the knowledge of hygiene extends, other diseases are being added “to the list. Nervous toothache, neuralgia, scarlet fever, cholera, “dysentery, diphtheria, cerebro-spinal meningitis and consumption “are among those which are either generated by foul air or foul “water, or which are made worse because of unhealthy surround-“ings.”

“Typhoid fever is the most conspicuous class of zymotic diseases, “all of which are clearly pythogenic, and none of which can origin-“ate under conditions fit for proper human habitation. In every “household in which a pronounced case of typhoid occurs it may “fairly be assumed that the value of the whole family to the com-“munity and themselves is distinctly lessened ; and the large pro-“portion of *debilitated and weakly* persons found in all our commu-“nities are but half-way victims struggling against the assaults of “foul air and contaminated water. Their lives are permanently “dulled by a malaria they are in part able to withstand.”

The following table from Baldwin Latham’s “Sanitary Engineering,” shows the effect on health of sanitary works in different parts of England.

NAME OF PLACE.	Population in 1861.	Average mortality per 1000 before construction of works.	Average mortality per 1000 after completion of works.	Saving of Life per cent.	Reduction of Typhoid Fever rate per cent.	Reduction of rate of Phthisis per cent.
Banbury..	10,238	23.4	20.5	12½	48	41
Cardiff.................	32,954	33.2	22.6	32	40	17
Croydon................	30,229	23.7	18.6	22	63	17
Dover.	23,108	22.6	20.9	7	36	20
Ely......	7,847	23.9	20 5	14	56	47
Leicester.........	68,054	26.4	25.2	4½	48	32
Macclesfield	27,475	29.8	23.7	20	48	31
Merthyr...............	52,778	33.2	26.2	18	60	11
Newport...............	24,756	31 8	21 6	32	36	32
Rugby....	7,818	19.1	18.6	2½	10	43
Salisbury...............	9,030	27.5	21.9	20	75	49
Warwick....	10,570	22.7	21.0	7½	52	19

BROCKVILLE MORTALITY.

An examination of the appendix will show the alarming rate of mortality in Brockville from diphtheria, pre-eminently a filth disease.

In the years 1883, 1884 and 1885, the number of deaths from this preventable disease exceeded that from any other cause.

Phthisis (or consumption) stands second on the list. Then follow in order, old age, pneumonia, heart disease, typhoid fever, diarrhœa and dysentery, all of which except old age and heart disease will decrease with the completion of a thorough system of drainage.

The following is a summary of mortality from the most prevalent diseases in Brockville during the years 1883, 1884 and 1885.

Year.	Diphtheria.	Phthisis.	Old Age.	Pneumonia.	Heart disease.	Typhoid Fever	Diarrhœa and Dysenterry.	Total deaths in year.	Population.
1883	19	20	11	9	6	5	1	155	8141
1884	15	10	9	7	1	5	6	113	8499
1885	17	16	10	12	13	4	6	144	8414
	51	46	30	28	20	14	13	412	

The pecuniary value of a decrease in mortality may be shown as follows :

1st—Saving in funeral expenses.

2nd—Saving to the community of valuable labor.

3rd—Saving from a decrease in sickness.

It is safe to estimate each funeral to cost $25.00 ; each adult is worth at least $600 to the community, in fact an adult is generlly put down as worth $1,000 to the community and each case of sickness prevented a saving of at least $10.00.

Upon the completion of sewers there would be a decrease in deaths of about 20 annually, of whom 5 would be adults. The total cash saving would therefore be as follows :

20 funerals @ $25 each	$ 500
5 adults @ $600 each	3000
350 cases of sickness @ $10 each	3500
Total	$7000.

This amount capitalized at 5 per cent. gives $140,000, which is more than the estimated cost of sewers.

STREET IMPROVEMENT.

It is unnecessary to multiply testimony to show advantages of sewers from a sanitary point, it only now remains to show how pecuniary benefits are to be derived. Our streets during many months of the year are in a horrible state, simply because they have no efficient drainage. During any heavy shower of rain we find even on King street, ponds of water extending to half the length of a block, and of one-fourth the width of the street. This water upon oozing into one of our municipal cesspools, deposits its suspended earth and filth upon the roadbed, the vapors and gases from which pass into the air, while the roadway is kept continually moist, and it is thus impossible to maintain a good roadway. A poor road or street means a direct loss to the town.

Upon the completion of a sewer on a street it can then be improved and the storm water conveyed safely away in cheap underderground drains or by surface drainage to a point where it can do no damage.

SYSTEMS OF SEWERAGE.

The following materials must be removed from the populous parts of a town, or else be disinfected and deodorized :

1. Human fæces or night-soil.
2. Kitchen and other household wastes.
3. Accumulations of manure from domestic animals.
4. Wastes from manufactories, &c.
5. Storm water.
6. Ashes and Garbage.

The system of water-carriage removal is the one in general use throughout the United States and Canada. There are three varieties of this system known as the

(1) Combined system.
(2) Restricted system.
(3) Separate system.

By the first system the sewers carry all the storm water and all the refuse that can find an entrance into sewers. In the restricted system most of the storm water is excluded, while in the separate or Waring system house sewage and manufacturing wastes only are admitted, the storm water being removed by a second system of pipes, or by open drains to the nearest water courses.

Each of these systems has its advantages and each its advocates. The first system is undoubtedly the most expensive, the average cost of sewers in several cities of the United States that have the combined system ranging from $16,000 to $35,000 per mile, while in those adopting the separate system the cost ranges from $6,000 to $10,000 per mile. If a city or town is so situated that all surface and storm water can be turned into natural water courses, through short and inexpensive drains, then the separate system should be adopted. In making preliminary estimates for sewerage where the separate system is proposed, the expense of getting rid of storm water is often overlooked, the sewers proper in this case costing less while street improvements will cost very much more.

The restricted system is intermediate in cost between the other two. In my opinion any one of these systems, if honestly carried out, could be relied on to fulfil all necessary sanitary requirements, safely and satisfactorily.

LOCATION OF OUTFALL SEWERS.

The town of Brockville is peculiarly situated. The river St. Lawrence flows north-easterly along its front while at the rear a mill creek flows in the opposite direction; this turns an approximate right angle and empties into the river at the western part of the town. At the eastern town limit on King street, the elevation above river datum is 100 feet, and as we go westward this elevation decreases to 40 feet at Bethune street and 33 feet at Mill street. A line drawn parallel to river and about midway between river and creek would approximate to watershed between the two.

In the proposed plan all sewage of the area between the north side of Pearl street to north, Perth street to west, and King street to south and the eastern town limit is emptied through one outfall sewer.

The first great point to determine was the location of this outfall. The river in front of the town is a little over one mile in width with an average depth of about 50 feet, the current being about one-half mile per hour. Examinations were made of currents of the river on several occasions, the directions at different points being shown on the accompanying map. The projection into the river of the C.P.R.

wharves, in the central part of the town, produces two eddies in the river, one above, the other below the said wharves. From the lower eddy our water supply is taken, from a point 300 feet from the shore in 45 feet of water, at which point the current is generally *down*, but sometimes *up*.

Into the upper eddy the dirty muddy waters of the mill creek empty. The drainage of part of the town now discharges by this creek. This creek water can be traced up stream nearly three-fourths of a mile. Even with a gale blowing down the river the line of demarcation between the river water and the creek water is quite plain a considerable distance up stream.

The effect of the water of the creek on the river is probably about the same as if the creek emptied into the river about a mile above its present junction.

The location of the water supply pipe in the lower eddy precludes any idea of allowing sewage to be discharged into it, and therefore sewage must be emptied below this eddy, or carried by pipe out into the current of the river beyond the water supply pipe far enough to prevent any suspicion of contamination, or emptied above C. P. R. wharves in the upward current of the upper eddy. As the town slopes downward toward the west I adopted the last method, at first locating the main outfall sewer at the foot of Mill street, but upon Col. Waring advising the separate system Home street has now been selected. The sewage of the greater portion of the most populous part of the town will be carried out into the river at this point beyond the C. P. R. wharves, through a flexible iron pipe, a description of which is given in Col. Waring's report.

This pipe will carry the sewage out into the river to where there is always a strong, constant current. If an analysis of the water from the water supply should show a trace of sewage matter, then either the inlet pipe to the water works pumping station will need to be extended out into the river till pure water can be obtained, or else the pumping station will have to be removed to the west end of the town above or south of the upper eddy.

SYSTEM OF MAIN SEWERS.

The system of main sewers as now proposed to be adopted is as follows :

A main sewer down King street from the east end of the town to

Perth street, intercepting sewers coming down all the cross-streets from the north. The main down John street, which connects with the King street main, will intercept the sewers on Pearl, James, Church and George streets.

The outfall pipe at the foot of Home street will then be reached either directly down Home street from King street or by Mill street, Jones street, and across private property to Home street.

Whatever system be adopted considerable sewage must for some time be emptied into the creek, and Col. Waring anticipates that at some future day a sewer must be constructed up the valley of the creek to intercept all sewers emptying into it.

The Brock street sewer will for the present empty into the creek, also the sewers on streets west of Perth and north of King.

A main sewer will extend along King from McCrady street to Ann street, thence down Ann to Hartley street thence to the river.

All that portion of the town south of King street and east of the market will be sewered by an outfall located at Ferry street.

The main along Water street west and Jane street will intercept the sewers on Market square (west side), Broad, St. Andrew and Apple streets, connecting with the main outfall on Home street.

OBJECTIONS TO KING STREET SEWER.

Much objection has been made to the proposal of constructing a sewer on King street, from Court House avenue to John street, owing to the large amount of rock met with, and to the fact that a sewer along King street cannot be of so much benefit to a resident on the south side of the street as to one on the north side. While in many cases the residents of the south side might be better served by the sewers on the cross-streets, with laterals extending through private property and lanes, the residents of the north side cannot be so well served.

The main sewer might leave King street at Broad street or at Market square, and continue along Water and Jane streets to Home street. The residents on the north side of King street might then get relief by short laterals running to the cross-streets, and those on the south side by laterals through lanes and private property.

This is a question that can only be decided by a thorough examination of King street, the lanes at the rear of the lots on the south side of King street and of the cross-streets near King street.

Estimates can then be made of the rock work, taking into consideration the private drain connections, and the cost of the different routes compared. Outside speculation and guesswork cannot decide this question.

ESTIMATED COST.

The estimated total cost of the sewers required in the immediate future is $66,000, which will construct between 10 and 12 miles of sewers. Of this amount the municipality should pay for the crossings or street intersections, part of frontage of corner lots and irregular pieces of land, and of property specially exempt; also for cost of outlet pipe, This amounts to a total of $10,000, and this leaves a balance of $56,000. It is proposed that the property fronting on drains be taxed to pay $36,000 of this amount, and the town assumes the remaining $20,000.

By this proposed method the part of cost paid by the property owners is such that sewers will not be asked for until they become necessary, while the part paid by the town will be an inducement towards the construction of sewers on streets where the excavation would be expensive, and such as the improved sanitary condition of the town will be worth to the community.

SUGGESTIONS.

(Taken from Report of Nov. 2nd, 1885.)

In conclusion I will add a few suggestions and recommendations gathered from the examination of sewerage systems of many cities in New York and in the New England states.

1st.—The town should proceed at once with the construction of the John street and King street mains, the laterals to be built as required

2nd—The construction of all sewers and connections should be done by the town, but on any street where a sewer is constructed all lots should be assessed a certain fixed price per foot frontage, with an equitable plan for corner lots. The municipal Act of 1884 and 1885 confers all necessary powers upon corporations to make local assessments. It is wholly unfair to ask a ratepayer living on Richards' Hill to pay as much toward a sewer on Brock street as a person living on said street. By adopting the frontage tax system, the corporation will only be asked to build sewers as required by property owners.

An inspection of Appendix No. 2, (not printed, but in the hands of the committee), shews several methods of assessments for the construction of sewers, but that of Providence, R. I., appears to me to be the most equitable, except in cases of corner lots. With scarcely an exception, all towns and cities visited had some system of frontage tax for sewers.

3rd.—As soon as sewers are built on any streets the town should stop all connections with the old street drains or old sewers, and as soon as possible thereafter, insist on filling in all privy vaults and cesspools.

4th.—No private party or private plumber should be allowed to make any connections with, or in any way interfere with any sewer; all such work to be done by corporation employees, or at least by reliable plumbers, licensed to do such work, who shall apply for permits before doing any work and report on the same after completion. All work to be subject to inspection and approval of the corporation.

5th.—All house drains, soil pipes and other connections with sewers to be constructed subject to the approval of the Board of Health and Board of Works, when such Boards are established, or of their executive officers.

WILLIS CHIPMAN,
Civil Engineer.

APPENDIX.

DEATHS AND CAUSES, BROCKVILLE, 1883.

Cause of Death.	Sex.		Age						Total.	Percentage for each Cause.
	Male.	Female.	Under 1	1 and under 5	5 and under 20	20 and under 50	50 and under 70	70 and over		
CLASS I.—ZYMOTIC.										
Diphtheria	8	11		9	9	1			19	12.26
Typhoid Fever	3	2			2	2		1	5	3.22
Croup		2		1	1				2	1.28
Septicæmia (blood poisoning)	2		1		1				2	1.28
Diarrhœa and Dysentery	1		1						1	0.64
Cholera Infantum		1	1						1	0 64
Whooping Cough	1			1					1	0.64
Erysipelas	1								1	0.64
CLASS II.—CONSTITUTIONAL.										
Phthisis (consumption)	7	13		1	4	13	2		20	12.90
Tubercular Meningitis	2	1	2		1				3	1.93
Hydrocephalus	2		2						2	1.28
Cancer	1						1		1	0.64
Anæmia		1			1				1	0.64
Apoplexia Pulmonaris		1				1			1	0.64
CLASS III.—LOCAL.										
Order 1, Nervous—										
Eucephalitis	1	2			2	1			3	1.93
Convulsions		1	1						1	0.64
Order 2, Circulatory—										
Heart Disease	1	6				1	3	2	6	3.87
Cerebral Hemorrhage		2			1	1			2	1.28
Dropsy		1				1			1	0.64
Apoplexy		1				1			1	0.64
Order 3, Respiratory -										
Pneumonia (Inflammation Lungs)	5	4	2	2		3	1	1	9	5.80
Congestion of the Lungs	2	1	2		1				3	1.93
Bronchitis	1	1	1					1	2	1.28

Cause of Death	Sex.		Age.						Total.	Percentage for each Cause.
	Male.	Female	Under 1	1 and under 5	5 and under 20	20 and under 50	50 and under 70	70 and over		
Pleurisy		1					1		1	0.64
Order 4, Digestive—										
Enteritis, (inflammation of bowels)	2	3	2		1	2			5	3.21
Peritonitis, (" peritoneum)	1	2			2		1		3	1.93
Gastritis, (" stomach)	2				1		1		2	1.28
Order 5, Urinary—										
Gravel	1							1	1	0.64
CLASS IV.—DEVELOPMENTAL.										
Order 1, Children—										
Congenital Debility	2	1	3						3	1.93
Premature Birth	1		1						1	0.64
Order 2, Women—										
Metritis		1				1			1	0.64
Post partum hemorrhage		1				1			1	0.64
Order 3, Old People—										
Old age	3	8					1	10	11	7.09
CLASS V.—VIOLENCE.										
Killed on Railway	3				1	2			3	1.93
Drowned	2					2			2	1.28
Fracture of Skull	1						1		1	0.64
Fall		1			1				1	0.64
CLASS VI.—SURGICAL DISEASES.										
Tumor		1				1			1	0.64
Abscess		2	2						2	1.28
Carbuncle	1						1	1	1	0.64
Gangrene	1								1	0.64
Spina Bifida		1	1						1	0.64
Unclassified and unknown	17	8	17		3	1	1	3	25	16.13
Total deaths, 1883	...	...	..	..	.	..	...	..	155	

DEATHS AND CAUSES, BROCKVILLE, 1884.

Cause of Death.	Sex.		Age.						Total.	Percentage for each Cause.
	Male.	Female.	Under 1.	1 and under 5	5 and under 20	20 and under 50	50 and under 70	70 and over		
CLASS I.—ZYMOTIC.										
Diphtheria	7	8	1	3	10				15	13.51
Diarrhœa and Dysentery	3	3	5					1	6	5.40
Typhoid Fever	3	2			1	3	1		5	4.50
Cholera Infantum		3	3						3	2.70
Measles	3			3					3	2.70
Scarlet Fever		1		1					1	0.90
Croup	1				1				1	0.90
CLASS II.—CONSTITUTIONAL										
Phthisis (consumption)	3	7			1	8	1		10	9.00
Hydrocephalus	1	1	2						2	1.80
CLASS III.—LOCAL										
Order 1, Nervous—										
Convulsions	2	1	3						3	2.70
Epilepsy		2			2				2	1.80
Paralysis	2					2			2	1.80
Encephalitis		1		1					1	0.90
Softening of Brain		1					1		1	0.90
Chorea		1		1					1	0.90
Order 2, Circulatory—										
Heart Disease		1				1			1	0.90
Order 3, Respiratory—										
Pneumonia	5	2	1	3	1	2			7	6.30
Asthma	1	2		1			2		3	2.70
Congestion of Lungs	2		1					1	2	0.90
Bronchitis	1							1	1	0.90
Order 4, Digestive—										
Hepatitis		1					1		1	0.90
Gastritis	1		1						1	0.90
Enteritis	1		1						1	0 90
Peritonitis	1		1						1	0.90

Cause of Death.	Sex.		Age.						Total.	Percentage for each Cause
	Male.	Female.	Under 1.	1 and under 5	5 and under 20	20 and under 50	50 and under 70	70 and over		
Order 5, Urinary—										
Diabetes........		1				1			1	0.90
CLASS IV.—DEVELOPMENTAL.										
Order 1, Children—										
Congenital Debility..	3	1	4						4	3.60
Undeveloped		1	1						1	0.90
Still-birth	1		1						1	0.90
Order 2, Women—										
Puerpural Fever...............		2				2			2	1.80
Phlegmasia-dolens..............		1				1			1	0.90
Order 3, Old people—										
Old Age.......................	2	7						9	9	8.10
CLASS V.—VIOLENCE.										
Drowned.......................	1	1			2				2	1.80
CLASS VI.—SURGICAL DISEASES.										
Tumor..........................		1						1	1	0.90
Hernia, (strangulate)..........		1						1	1	0.90
Varix..................		1				1			1	0.90
Unclassified and unknown......	7	6	2	1	2	5		3	13	11.70
Total..................	..	..	..	..	..	..	..	..	113	

v. DEATHS AND CAUSES, BROCKVILLE, 1885

Cause of Death.	Sex.		Age.						Total.	Percentage for each Cause.
	Male.	Female.	Under 1.	1 and under 5	5 and under 20	20 and under 50	50 and under 70	70 and over		
CLASS I.—ZYMOTIC.										
Diphtheria	13	4		8	8	1			17	11.80
Diarrhœa and Dysentery	4	2	4	1			1		6	4.16
Croup	2	3		3	2				5	3.47
Typhoid Fever	1	3	1		1	2			4	2.77
Cholera Infantum	1			1					1	1.38
CLASS II.—CONSTITUTIONAL.										
Phthisis	11	5	1	1	4	9	1		16	11.11
Cancer		3				1	2		3	2.08
Tubercular Meningitis	1		1						1	0.69
Anæmia		1				1			1	0.69
Tonsilitis	1						2		1	0.69
CLASS III.—LOCAL.										
Order 1, Nervous—										
Eucephalitis	1	4	1	3					5	3.47
Paralysis	2	1				1	2		3	2.08
Cerebro Spinal Meningitis	1	1	2						2	1.38
Congestion of the Brain	1		1						1	0.69
Convulsions	1		1						1	0.69
Meningitis	1				1				1	0.69
Epilepsy		1					1		1	0.69
Order 2, Circulatory—										
Heart Disease	5	8			2	7	4		13	9.02
Dropsy	2						1	1	2	1.38
Order 3, Respiratory—										
Pneumonia	7	5	3	3	1	1	3	1	12	8.33
Congestion of Lungs		2					1	1	2	1.38
Pleurisy	1					1			1	0.69
Order 4, Digestive—										
Entritis	2				1	1			2	1.38
Gastritis	1						1		1	0.69

Cause of Death.	Sex		Age.						Total.	Percentage for each cause.
	Male.	Female.	Under 1.	1 and under 5	5 and under 20	20 and under 50	50 and under 70	70 and over		
Ulceration of Bowels		1			1				1	0.69
Peritonitis		1				1			1	0.69
Order 5, Urinary—										
Bright's Disease	2	1			1	2			3	2.08
Diabetes		1			1				1	0.69
CLASS IV.—DEVELOPMENTAL.										
Order 1, Children—										
Still-birth	2	1	3						3	2.08
Congenital Debility	3	1	4						4	2.77
Order 2, Women—										
Puerpural Fever		1				1			1	0.69
Post Partum Hemorrhage		1				1			1	0.69
Order 3, Old People—										
Old Age	4	6						10	10	6.94
Senilo Gangrene	1						1		1	0.82
CLASS V.—VIOLENCE.										
Scalding	1			1					1	0.69
Poisoning		1				1			1	0.69
Uuclassified and unknown	7	6	4		3	2	3	1	13	9.02
Total for 12 months	..	..	..	..	..	..	..	..	144	